NASA Facts

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Pathfinder

Leading the way in solar flight

Pathfinder-Plus was flown to a record altitude of approximately 80,201 ft. NASA photo EC 98 44621-252

Just imagine...

- An aircraft that could stay aloft all day, powered only by sunlight.
- An aircraft that is no more than a flying wing, able to maneuver without rudders, ailerons, tails, or other control surfaces typical of conventional aircraft.
- An aircraft that flies without an onboard human pilot, and is controlled remotely from a ground station.

At the NASA Dryden Flight Research Center at Edwards, CA, imagination has become reality, and that reality is the Pathfinder solar-powered, remotely piloted aircraft.

Aircraft Description

The Pathfinder is a lightweight, solar-powered, remotely piloted flying wing aircraft that is demonstrating the technology of applying solar power for long-duration, high-altitude flight. It is literally the pathfinder for a future fleet of solar-powered aircraft that could stay airborne for weeks or months on scientific sampling and imaging missions.

Solar arrays covering most of the upper wing surface provide up to 8,000 W of power at high noon on a summer day to power the aircraft's six electric motors, avionics, communications, and other electronic systems.

Pathfinder also has a backup battery system that can provide power for between 2 and 5 hours to allow limited-duration flight after dark.

Pathfinder flies at an airspeed of only 15 to 20 mph. Although pitch control is maintained by the use of tiny elevators on the trailing edge of the wing, turns and yaw control are accomplished by slowing down or speeding up the motors on the outboard sections of the wing.

Pathfinder was designed, built, and is operated by AeroVironment, Inc., of Monrovia, CA, the firm that developed the pioneering Gossamer Penguin and Solar Challenger solar-powered aircraft in the late 1970's and early 1980's.

Pathfinder solar-powered research aircraft in the morning sun on the bed of Rogers Dry Lake as technicians prepare it for flight. NASA photo EC96-43817-2

Pathfinder Flight History

Pathfinder was first developed for a now-cancelled government program in the early 1980's, and was adopted into NASA's Environmental Research Aircraft and Sensor Technology (ERAST) program in 1993. After initial flight tests at Dryden in that year, it was modified with additional solar arrays and other upgrades and was brought back for another series of development flights in 1995. On Sept. 11, 1995, Pathfinder reached an altitude of 50,500 ft, setting a new altitude record for solar-powered aircraft. The National Aeronautic Association presented the NASA-industry team with an award for one of the "10 Most Memorable Record Flights" of 1995.

After additional upgrades and one checkout flight at Dryden in late 1996, Pathfinder was transferred to the U.S. Navy's Pacific Missile Range Facility (PMRF) at Barking Sands, Kaua'i, Hawaii, in April, 1997. Kaua'i was chosen as an optimum location for testing the solar-powered Pathfinder due to high levels of sunlight, available airspace and radio frequencies, and the diversity of terrestrial and coastal ecosystems for validating scientific imaging applications. While in Hawaii, Pathfinder flew seven high-altitude flights from PMRF, one of which reached a world altitude record for propeller-driven as well as solar-powered aircraft of 71,530 ft.

Pathfinder-"Plus" Modification

During 1998, the Pathfinder, was modified into the longer-winged Pathfinder Plus configuration. On Aug. 6, 1998, the modified aircraft was flown to a record altitude of 80,201 ft for propeller-driven aircraft on the third of a series of developmental test flights from PMRF. on Kaua'i. The goal of the flights was to validate new solar, aerodynamic, propulsion, and systems technology developed for the Pathfinder's successor, the Centurion, which is designed to reach and sustain altitudes in the 100,000-ft range.

Essentially a transitional vehicle between the Pathfinder and the follow-on Centurion, the Pathfinder-Plus is a hybrid of the technology that was employed on Pathfinder and developed for Centurion.

The most noticeable change is the installation of a new 44-ft-long center wing section that incorporates a high-altitude airfoil designed for Centurion. The new section is twice as long as the original Pathfinder center section and increases the overall wingspan of the craft from 98.4 ft to 121 ft. The new center section is topped by more-efficient silicon solar cells developed by SunPower Corp., Sunnyvale, CA, that can convert 19 percent of the solar energy they receive to useful electrical energy to power the craft's motors, avionics, and communication systems. That compares with about 14 percent efficiency for the older solar arrays that cover most of the surface of the middle and outer wing panels from the original Pathfinder. Maximum potential power was boosted from about 7,500 W on Pathfinder to about 12,500 W on Pathfinder-Plus.

In addition, the Pathfinder-Plus was powered by eight more efficient electric motors designed for the Centurion, two more motors than had powered the previous version of Pathfinder. A new flight control system for the Centurion was installed and operated in parallel with the Pathfinder's own system, although only the Pathfinder system actually controlled the motors and control surfaces.

Environmental Monitoring Missions

Major science activities of Pathfinder missions have included detection of forest nutrient status, forest regrowth after damage caused by Hurricane Iniki in 1992, sediment/algal concentrations in coastal waters, and assessment of coral reef health. Science activities are coordinated by the NASA Ames Research Center, Moffett Field, CA, and include researchers at the University of Hawaii and the University of California.

Thus far, Pathfinder has flight tested two new scientific instruments, a high spectral resolution Digital Array Scanned Interferometer (DASI), and a high spatial resolution Airborne Real-Time Imaging System (ARTIS), both developed at Ames. These flights were conducted at altitudes between 22,000 and 49,000 ft in 1997.

Remotely piloted, solar-powered aircraft similar to Pathfinder, such as the follow-on Centurion now being developed and the planned Helios ultra-long-duration flying wings, could spend long periods of time over the ocean, monitoring storm developments to provide more accurate predictions of hurricanes. These aircraft could also be used to monitor major croplands, forests and other large, remote expanses to provide early warning of crop damage or fires.

The ERAST Program

Pathfinder is one of several remotely piloted aircraft being evaluated under NASA's Environmental Research Aircraft and Sensor Technology (ERAST) program. The ERAST program is one of NASA's initiatives designed to develop the new technologies needed to continue America's leadership in the highly competitive aerospace industry.

Additional technologies considered by the joint NASA-industry ERAST Alliance include lightweight materials, avionics, sensor technology, aerodynamics, and other forms of propulsion suitable for extreme altitudes and duration. The most extreme mission envisioned for solar-powered aircraft such as Pathfinder's successor, Centurion, would reach altitudes of 100,000 ft for science and commercial applications.

The ERAST program is sponsored by the Office of Aeronautics and Space Transportation Technology at NASA Headquarters, and is managed by the NASA Dryden Flight Research Center.

Aircraft Specifications

- **Wingspan:** Pathfinder 98.4 ft (29.5 m); Pathfinder-Plus 121 ft (36.3 m)
- **Length:** 12 ft (3.6 m)
- **Wing chord:** 8 ft (2.4 m)
- **Gross weight:** Pathfinder about 560 lb (252 kg.); Pathfinder-Plus about 700 lb (315 kg.)
- **Payload:** Pathfinder—up to 100 lb (45 kg.); Pathfinder-Plus up to 150 lb (67.5 kg.)
- **Airspeed:** Approx. 17-20 mph cruise
  Power: Arrays of solar cells, maximum output: Pathfinder—about 8,000 W; Pathfinder-Plus—about 12,500 W
- **Motors:** Pathfinder, six electric motors; Pathfinder-Plus, eight electric motors, 1.5 kw maximum each.
- **Endurance:** About 14 to 15 hours, daylight limited with 2 to 5 hours on backup batteries.
- **Manufacturer**: AeroVironment, Inc., Monrovia, CA.
- **Primary materials**: Composites, plastic, foam.